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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :		(11) International Publication Number:
B29C 45/16	A1	WO 93/17855
		(43) International Publication Date: 16 September 1993 (16.09.93)

(21) International Application Number: PCT/GB93/00453

(22) International Filing Date: 4 March 1993 (04.03.93)

(30) Priority data:
9204730.7 5 March 1992 (05.03.92) GB

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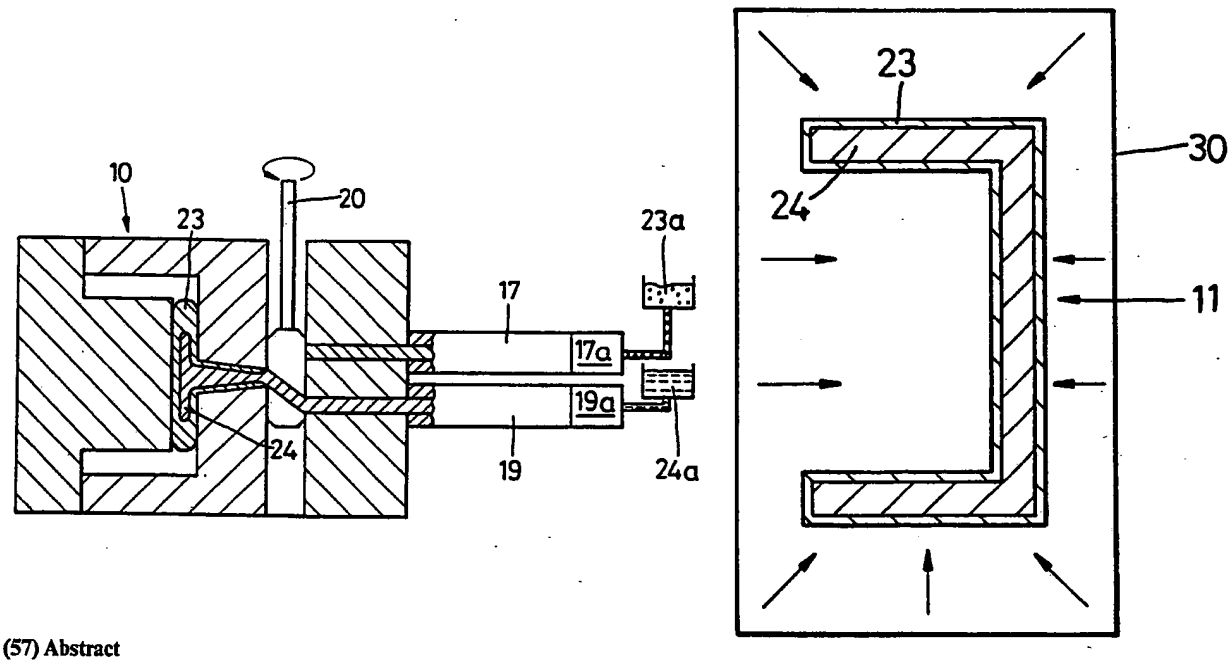
(81) Designated States: GB, JP, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: A METHOD OF FORMING A MOULDING BY DUAL INJECTION AND A MOULDING FORMED IN ACCORDANCE WITH SUCH A METHOD



(57) Abstract

The method involves providing a thermosetting powdered or granulated paint material (23a) which is heated to a plastic condition to form a plastics coating material (23) and injected into a mould. A thermoplastic substrate material (24) is then injected to spread the material (23) over surfaces of the mould so as to envelope the material (24). A moulding (11) is then produced comprising a substrate having a surface coated by the injected plastics paint material. The method enables a moulding to be produced having a painted surface produced in the mould thereby avoiding the need to apply a subsequent paint finish.

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A METHOD OF FORMING A MOULDING BY DUAL INJECTION AND A MOULDING FORMED IN ACCORDANCE WITH SUCH A METHOD

The invention relates to a method of forming a moulding by dual injection and a moulding formed in accordance with such a method. In particular, but not exclusively, the invention is concerned with the moulding of a vehicle body component in a way which will avoid having to apply a coating of paint to a pre-formed component.

Dual injection moulding is a technique involving injecting a first plastics material into a mould followed by a second plastics material. The injection steps causes the first material to coat the mould surfaces and the second material forms a substrate for the first. The component so formed may harden in the mould prior to removal from the mould.

An example of dual injection moulding is disclosed in GB-A-1,420,948. However any moulding produced by such a method will require subsequent painting outside the mould.

Another example of dual injection moulding is disclosed in GB-A-2 080 187 which describes a method of resin injection moulding (RIM) where a low viscosity liquid resin, for example liquid paint, is injected at low pressure (eg 7 bar) into a mould

followed by a higher viscosity liquid resin. The low viscosity liquid resin forms a coating for the higher viscosity resin. Such low viscosity paints take the form of a liquid thermosetting resin having coloured pigments which is injected in its uncured liquid form and subsequently cured. A disadvantage of using a low viscosity liquid resin is that of controlling accurately the spread of the liquid paint to produce a coating of uniform thickness. Therefore such a process is suitable only for the production of primer coats which have to be finished by applying a coat of paint in a conventional manner outside the mould, eg by paint spraying.

An increasing number of motor vehicles are now provided with components such as body panels made from plastics materials. For example it has been proposed to form a vehicle body component by initially injecting an unfilled thermoplastics material followed by a glass filled polymer material as a substrate. The unfilled plastics material thereby forms a smooth coating on the substrate ready to receive paint which is subsequently applied by spraying or dipping the cured moulding in a paint facility. We are unaware of any vehicle component being made by such a process which does not subsequently require a finishing paint coating applied outside the mould and the motor industry

continues to refine its painting facilities, which in themselves can involve large capital investment and on-going maintenance sums, and present environmental difficulties.

One object of the present invention is to provide an improved method of forming a moulding by dual injection which will render unnecessary the subsequent painting of the moulding or moulded component.

According to one aspect of the invention there is provided a method of forming a moulding by dual injection comprising injecting a plastics coating material into a mould and injecting a plastics substrate material into the mould to cause the coating material to coat a surface of the mould and to produce a moulding having a coating formed by the plastics coating material, characterised by providing the coating material as a powdered or granulated cross-linking plastics paint material and heating the powdered or granulated plastics paint material to a plastic condition for injection into the mould.

The powdered or granulated paint material heated to a plastic condition and applied in that way provides the required paint finish by an in-mould process which dispenses with the need to spray a coating of

paint subsequently on to the moulding. Also it has been found that the use of powdered or granulated plastics paint enables a much more controllable flow to be obtained in the mould resulting in a paint coating thickness which is controllable. Thus it is possible with the method of the present invention to obtain a very uniform and consistent paint finish on the moulding. Where this moulding is in the form of, say, a vehicle body panel, such a uniform and consistent finish is most advantageous from a point of view of aesthetics and quality control aspects. Moreover the use of powdered or granulated plastics paint gives a surprisingly good finish uncharacteristic of the "orange peel" effect normally obtained by spray or dip coating a surface with powdered plastics paint.

It is frequently a requirement with vehicle body paintwork that a metallic finish be provided. Typically such a finish is provided by adding metallic or mineral flakes or platelets to the liquid paint sprayed or dip applied to the body component. Spray or dip powder plastic coating is not used to give a metallic finish to vehicle bodywork because the metallic or mineral additives do not orientate in the desired manner and an unsatisfactory finish results. That is due to the fact that the powder coating during melting to form the coating must

retain a high viscosity impeding the movement of the additives. However by using a method in accordance with the invention, the injection process produces a flow of paint melt which, when containing such metallic or mineral additives, causes the additives to align or orientate to give the desired effect.

It is preferred particularly to use a powdered or granulated plastics paint of a thermosetting kind which has a thermoplastic phase. In such a case the powdered or granulated plastics paint can be heated sufficiently to bring it to a plastic condition (typically a putty-like condition) in its thermoplastic phase to enable it to be injected at high pressure into the mould (eg in excess of 1000 bar). For example heating a powdered or granulated plastics paint to a temperature in the range 80^0 to 260^0C will normally bring it to a plastic condition for injection into the mould. With such a coating material, the heat absorbed to bring it to the plastic phase may ideally be utilised to cause the material to begin thermosetting, e.g., as it coats the mould or after it has coated the mould following the introduction of the substrate material. In that way a reasonably rapid curing of the coating can be achieved once it has coated the mould. However, if desired, the coating can be cured or curing can be completed after removal of the moulding from the

mould, i.e. post cured.

Post curing enables the curing temperature and time to be particularly carefully controlled preferably with a view to creating a strong bond between the two materials.

The paint and substrate materials are preferably selected so as to have an affinity one for the other.

The method may include effecting cross-linking between the moulded coating and substrate material during moulding or during curing of the materials.

According to a second aspect of the invention there is provided a moulding formed by a method according to the first aspect of the invention or any of the consistory clauses related thereto.

The invention also includes a moulding formed by dual injection comprising a plastics substrate material having a plastics coating material thereon, characterised in that the plastics coating material is formed from a powdered or granulated plastics material which has been heated to a plastic condition, injected into the mould and cross-linked to form a cured coating.

A method of forming a moulding by dual injection and a moulding in accordance with the invention will now be described by way of example with reference to the accompanying drawings in which:-

Fig.1 is a diagrammatic cross section through part of a dual injection moulding machine showing the injection into a mould of a granulated plastics paint material in a plastic condition,

Fig.2 shows the introduction of a substrate material into the mould,

Fig.3 shows the form of the moulding after injection of the substrate material is complete,

Fig.4 shows a second injection of the powdered plastics paint material in a plastic condition to finish off the moulding step,

Fig.5 is a diagrammatic view of the moulding removed from the mould and placed in an oven for post curing the coating,

Fig.6 is a cross section to a larger scale through part of a component made by a method in accordance with the present invention,

Fig.7 is a cross section to a larger scale showing

this way in which a paint having metallic effect additives is moulded,

Fig. 8 is a perspective view of a vehicle wing in accordance with the present invention and including an encircled enlargement of a section of the wing and

Fig. 9 is a cross section of part of the wing of Fig. 8 on the line IX - IX in Fig. 8.

With reference to Fig.1, the injection moulding machine has a mould 10 having first and second halves 12, 13 defining a hollow cavity 14 therebetween. The hollow cavity 14 communicates with a block 15 which defines a passageway 16 for material from a first extruder 17 and a second passageway 18 for material from a second extruder 19. A rotary valve 20 is positioned between the block 15 and an inlet port 22 in mould half 13 for selection of the material to be injected into the cavity 14.

The extruder 17 is associated with a heater 17a and is operated to deliver a coating material 23 formed by heating thermosetting granulated plastics paint material 23a into a thermoplastic phase in which it takes on a putty-like plastic condition. A suitable granulated plastics paint material has been found to be one which will have a plastic condition at a temperature of around 170^0 with a putty-like viscosity. Suitable materials are, the EvoShield (Trade Mark) range of materials available from Evode Powder Coatings Limited, Birmingham, England. With such material cross-linking is initiated at the above

temperature and begins during the moulding stage, completion of curing taking place in the mould cavity 14. Other thermosetting granulated paint materials, eg Interpon UT 1410 available from Courtaulds Coatings (Holdings) Ltd. of Felling Gateshead, Tyne and Wear, England require post curing after removal of the moulding from the mould cavity.

As shown in Fig.1, an initial quantity of the coating material 23 is injected into the cavity 14, the mould being at a temperature in a range of, for example, 20°C to 100 °C. The valve 20 is then rotated to shut off feed of material 23. As shown in Fig.2, a thermoplastics substrate material 24 such as ABS or nylon 24a is heated in a heater 19a associated with the second extruder 19 and is injected into the cavity 14 behind the injected material 23 as shown in Fig.2. Injection of the material 24 causes the material 24 to spread the coating material 23 over the mould surfaces 14a defining cavity 14 and injection is continued until the surfaces are coated with the material 23 and the material 23 envelopes the material 24. The material 24 thus forms a thermoplastics substrate or core as shown in Fig.3 having a coating or skin formed by the material 23.

In Fig.4, the valve 20 is rotated again to shut off feed from the extruder 19 and to permit injection of

coating material 23 into the port 22 so that the machine is ready for another injection cycle.

The heat applied to the thermosetting coating material 23 while it is temporarily in the extruder 17 is absorbed by the material and, once in the mould 10, the heat will begin the curing process of the material. That process may begin as the material is being spread over the mould surfaces by the incoming substrate material or may begin after the injection steps are complete. Preferably, however, the curing of the thermosetting coating material 23 and substrate material 24 will allow sufficient time to enable cross-linking to take place between the two materials thereby ensuring an extremely good bond between them. Instead of a cross-linking occurring between the coating and substrate materials, a good bond alone may be achieved between them due to their intimate contact during injection.

If additional heat is required to cure the thermosetting coating material 23, the moulding (indicated at 11 in Fig.5) can be removed from the mould 10 and placed in an oven 30. The oven is pre-heated to a temperature of around, for example 250°C. The moulding 11 is subjected to heat at that temperature as indicated by arrows for a period which is sufficient to cure the coating material 23 but

which is insufficient to have a significant softening effect on the bulk of the thermoplastics substrate material 24. It is believed that with careful control of timing and temperature, a good bond will be achieved between the coating material 23 and the substrate material 24.

The substrate material 24 is preferably selected so that it will have an affinity to the coating material 23 and materials such as ABS and nylon constitute suitable substrate materials for such a coating material 23.

The depth d (Fig.6) of the coating material 23 can be selected to be at least as thick as a paint coating which would normally be applied to, say, a car body component in a paint spraying or dipping facility. Also, the injection moulding tool 10 can provide a superfine surface finish for the coating which will compare well with that obtained by spray or dip painting. Moreover, by producing a coating in a dual injection moulding process, the finished coating will be free from contamination by air-borne dust as well as being uniform and consistent. Also, the method is cleaner and more environmentally friendly than producing a finish using a conventional paint facility as the process does not involve extracting contaminated air or effluent from a paint facility

into the atmosphere.

If desired, the substrate material 24 can be a thermosetting material instead of a thermoplastics material. The injection steps will be the same as that described above with reference to the drawings except that the mould will be hotter eg at a temperature in a range 100°C to 180°C. As before, the heat absorbed by the granulated plastics paint 23a to bring it to a plastic condition will lead to the onset of curing and the hot mould will speed up curing of the coating formed by coating material 23. The heat from the mould may also at least partially cure the substrate material 24. If desired the moulding can be left to cure completely in the mould 10 or can be removed for post curing outside the mould, e.g., in the oven 30. In the latter case heat applied to the thermosetting substrate material 24 will not present any distortion problems to the thermosetting materials.

The substrate material 24 may be injected as a foamed thermoplastics/thermosetting material.

In the case where a metallic finish is required, reference is now made to Fig. 7. The granulated plastics paint coating material 23a has metallic or mineral flakes 40 added. The flakes 40 provide a

metallic finish in the paint coating. It has been found that as the coating material 23 spreads over the surfaces 14a of mould cavity 14, the spreading or flowing action causes the flakes 40 to orientate themselves so that they lie generally in a plane parallel with the flow or spread direction indicated by arrow F and generally parallel with the plane of the coating formed by the coating material 23. Also the flakes 40 are constrained to lie within the confines defined by the surfaces 14a of cavity 14 so as not to project from the finished paint surfaces of the moulding.

It has hitherto not been possible to achieve a metallic finish using powdered plastics paint coatings. That is due to the fact that the required thickness and viscosity of normal spray/dip powder paint coatings is too great to allow the metallic or mica flakes to orientate in the desired manner. However the method in accordance with the invention produces surprisingly good results when a metallic finish is required in view of the fact that the relatively thin paint layer, together with the effect of flow on the flakes, provides the required orientation for an acceptable metallic finish.

It is envisaged that the method in accordance with the invention can be used to produce by injection

moulding various body components of a motor vehicle having a paint finish provided by the coating material 23.

An example of a vehicle body wing in accordance with the invention is shown in Figures 8 and 9.

Utilising a mould normally used for the injection moulding of a vehicle front wing 50 for subsequent spray or dip painting after it has been removed from the mould, the mould was positioned on a machine for providing dual injection of plastics material. The two extruders of the machine were supplied with coating and substrate materials 23,24 respectively.

The coating material used was granulated blue EvoShield paint PPP (ie that paint in the EvoShield range suitable for coating polypropylene) which was heated to a temperature of 190°C. Such heating brought the coating material to its plastic phase enabling it to be injected by its extruder into the mould using an injection pressure of around 1300 bar. The granulated EvoShield paint was mixed with an additive comprising metallic and mica flakes to provide a metallic finish to the wing 50.

The substrate material 24 was white polypropylene and was heated to a temperature of 230°C to enable it to

be injected by the second extruder at a pressure of 1300 bar.

Using the injection method as described with reference to Figures 1 to 4 with the mould heated to a temperature of 60°C, the materials 23, 24 were injected into the mould and the moulded materials were left in situ in the mould for a period of around 90 seconds to allow the materials to cure. The moulded wing 50 was then removed from the mould and inspected.

It was found that the coating material 23 had completely enveloped the substrate 24 leaving no light patches or uncovered areas.

The mould itself did not have mould cavity surfaces of a quality which would enable a high gloss finish to be obtained as wings normally made in the mould were intended for post mould painting by spraying or dipping. Nevertheless, the finish obtained with the moulded plastics paint material was extremely good giving a metallic paint appearance comparable with that normally acceptable on motor vehicle body panels. The moulding demonstrated clearly that a mould cavity having a superfine finish would enable high gloss body panels to be produced by a method in accordance with the invention with no sign whatsoever

of the typical "orange -peel" finish characteristic of powder paint coatings.

The depth d of the paint coating material 23 on the polypropylene substrate material 24 could be controlled by varying the quantities of the materials 23, 24 injected into the mould and it was found that the two materials cross-linked well rendering the coating and substrate highly resistant to separation.

The wing 50 was moulded so as to include integral fixing flanges 52, 53 with fastener receiving apertures 52a, 53a therein and a stiffening flange 54. It was found that the paint coating material 23 enveloped the edges of the flanges and the apertures leaving no gaps where the white polypropylene was visible.

It was found that the same results were obtained on repeating the moulding process and with the vehicle front wing selected for the experiment (suitable for use on a Rover Maestro vehicle) it was found possible to provide wing mouldings by a method in accordance with this invention at a rate of one wing every 120 seconds.

The plastics paint material 23a used is of a kind which has hitherto been used in powder form for spray

or dip coating of a surface. With spray or dip coating using powder paint, the powder coated surface is subsequently heated so that the powder melts whilst retaining a high viscosity, coalesces and forms a paint finish on the surface. The material is normally produced as a solid sheet of plastics paint which is then ground into a powder or into a granulated form, the latter being the preferred form for use in the method according to the present invention for flowability to the extruder 17 from its hopper 42 although a powdered form may be used.

CLAIMS

1. A method of forming a moulding by dual injection comprising injecting a plastics coating material (23) into a mould (10) and injecting a plastics substrate material (24) into the mould to cause the coating material to coat a surface of the mould and to produce a moulding (11) having a coating formed by the plastics coating material (23), characterised by providing the coating material (23) as a powdered or granulated cross-linking plastics paint material (23a) and heating the powdered or granulated plastics paint material to a plastic condition for injection into the mould.

2. A method according to Claim 1 characterised by providing the powdered or granulated plastics paint material (23a) as a thermosetting material having a thermoplastic phase and heating the thermosetting powdered or granulated plastics paint material to bring it to its plastic condition.

3. A method according to Claim 2 characterised by heating the powdered plastics paint material (23a) to around 80^0 to 260^0C to bring it to a plastic condition for injection into the mould (10).

4. A method according to Claim 2 or 3

characterised by causing the heat absorbed by the powdered or granulated plastics paint material (23a) to bring it into a plastic condition for injection also to cause the plastics coating material (23) to begin thermosetting during the moulding process.

5. A method according to Claim 2 or 3 characterised by curing the coating (23) formed by the heated powdered or granulated plastics paint material (23a) after removing the moulding (11) from the mould (10).

6. A method according to any preceding Claim characterised by forming the substrate from a thermoplastics material.

7. A method according to Claim 6 when appendant to any of Claims 2 to 5 characterised by applying heat to the surface of the mould (10) so as to cure the plastics coating material (23) before the applied heat from the mould surface (14a) has any substantial softening effect on the substrate.

8. A method according to any preceding Claim characterised by providing a said powdered or granulated plastics paint material (23a) as one which has some affinity to the substrate material.

9. A method according to any preceding Claim characterised by effecting cross-linking between the moulded plastics coating material (23) and substrate material (24) prior to or during curing of the materials.

10. A method according to any preceding claim characterised by providing flake-like additives (40) to the powdered or granulated plastics paint material (23a) and utilising spreading action of the plastics coating material formed therefrom in the mould (10) to orientate the flakes (40) so that they lie generally parallel with the flow or spread direction (F).

11. A method of producing a component by dual injection substantially as described herein with reference to the accompanying drawings.

12. A moulding formed by dual injection comprising a plastics substrate material (24) having a plastics coating material (23) thereon characterised in that the plastics coating material (23) is formed from a powdered or granulated plastics material (23a) which has been heated to a plastic condition, injected into the mould and cross linked to form a cured coating.

13. A moulding according to Claim 11 characterised in that powdered or granulated plastics material (23a) is a thermosetting material having a thermoplastic phase.

14. A moulding according to Claim 12 or 13 characterised in that the plastics coating material (23) has been cured in the mould (10) using the heat absorbed to bring it to a plastic condition to initiate thermosetting.

15. A moulding according to Claim 12 or 13 characterised in that the plastics coating material (23) has been cured after removing the moulding (11) from the mould.

16. A moulding according to any of Claims 12 to 15 characterised in that the plastics coating material (23a) is one which has some affinity for the substrate material (24).

17. A moulding according to any of Claims 12 to 16 characterised in that the substrate material (24) is a thermoplastic material.

18. A moulding according to any of Claims 12 to 17 characterised in that the plastics coating material (23) is cross-linked with the substrate

material (24).

19. A moulding according to any of Claims 11 to 18 characterised in that the plastics coating material (23) includes flake-like additives (40).

20. A moulding according to Claim 19 in which the flake-like additives (40) lie generally in a plane parallel with the plane of the plastics coating material (23) when moulded.

21. A moulding formed by dual injection constructed and arranged substantially as described herein with reference to the accompanying drawings.

22. A moulding according to any of Claims 12 to 21 in the form of a vehicle body part.

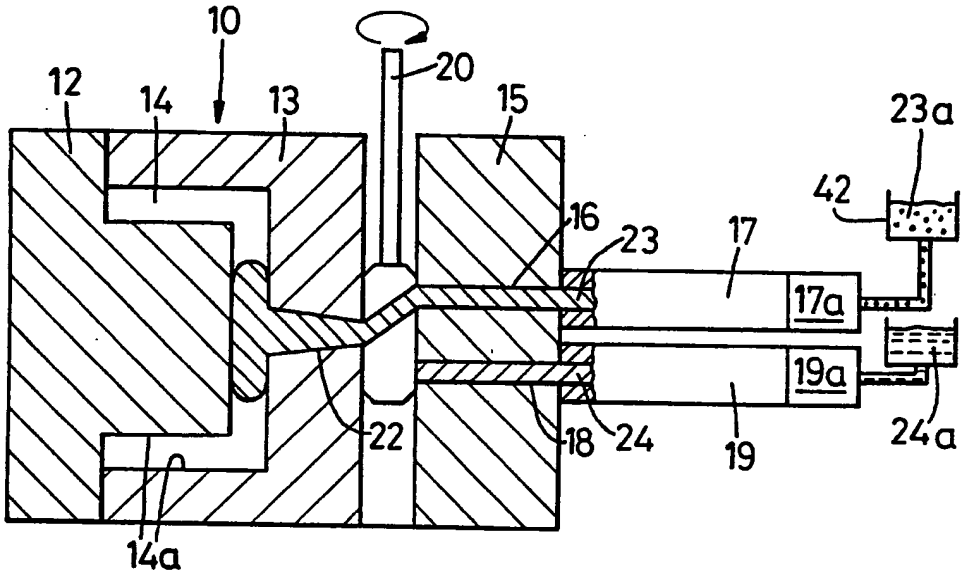
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Fig. 1

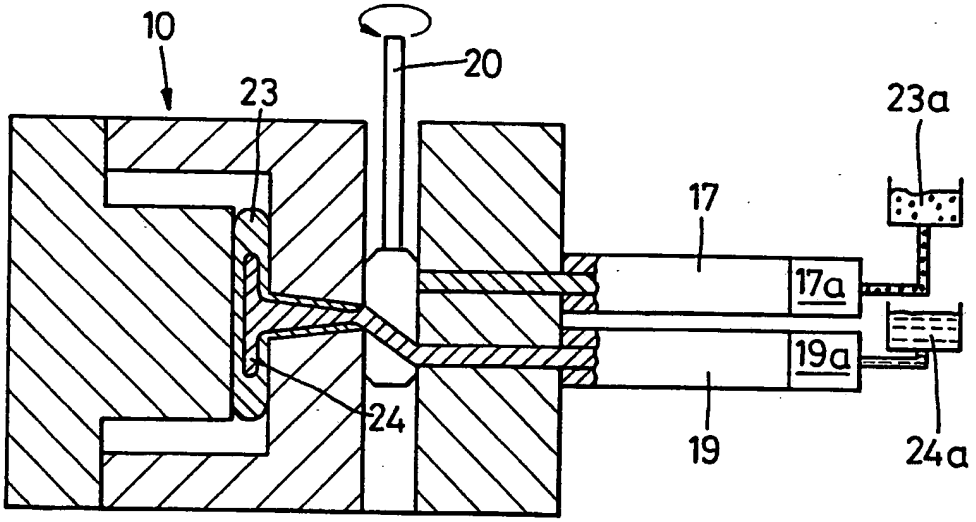
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Fig. 2

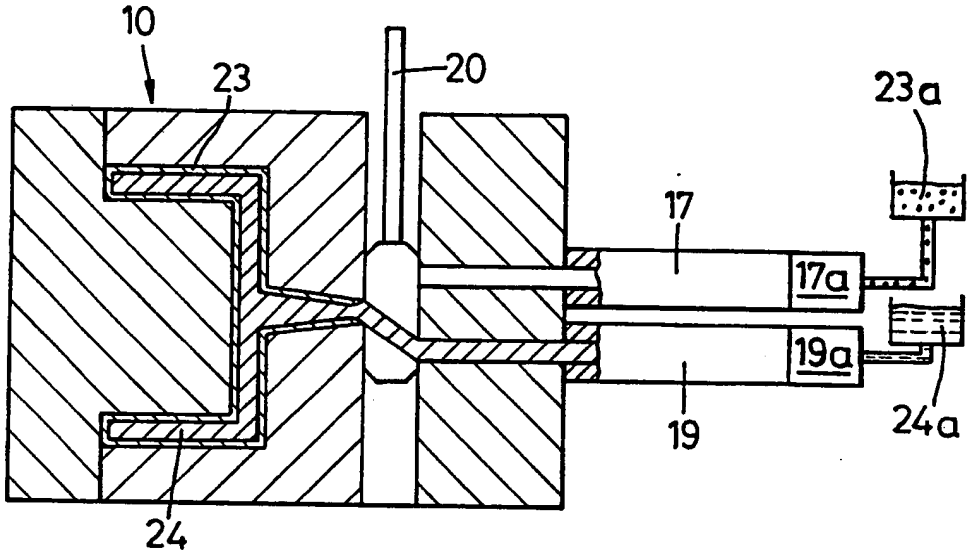

Fig. 3

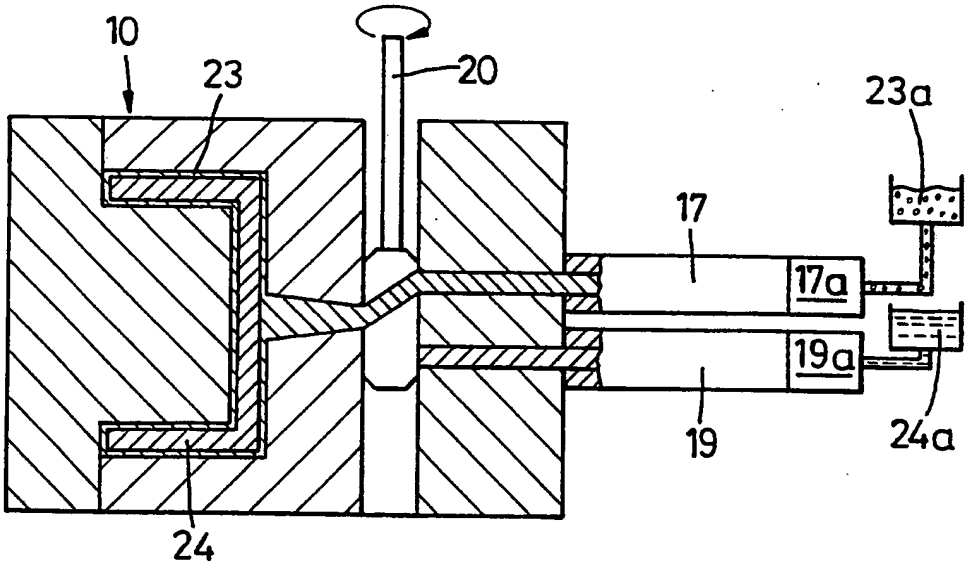

Fig. 4

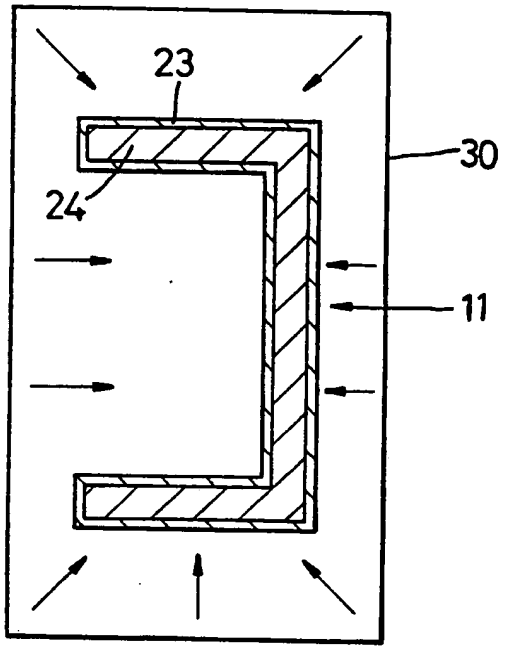

Fig. 5

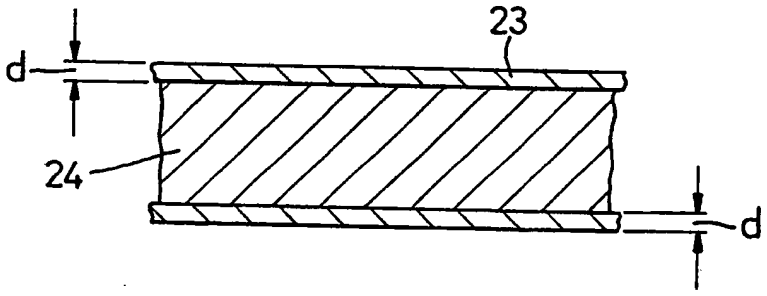

Fig. 6

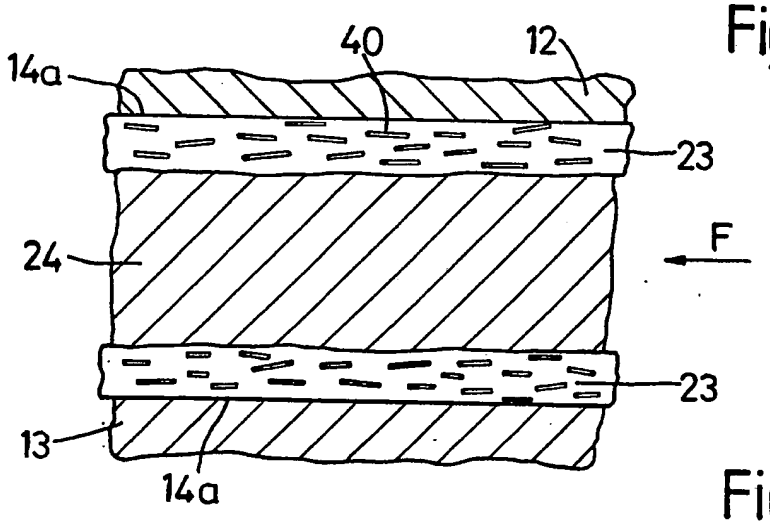

Fig. 7

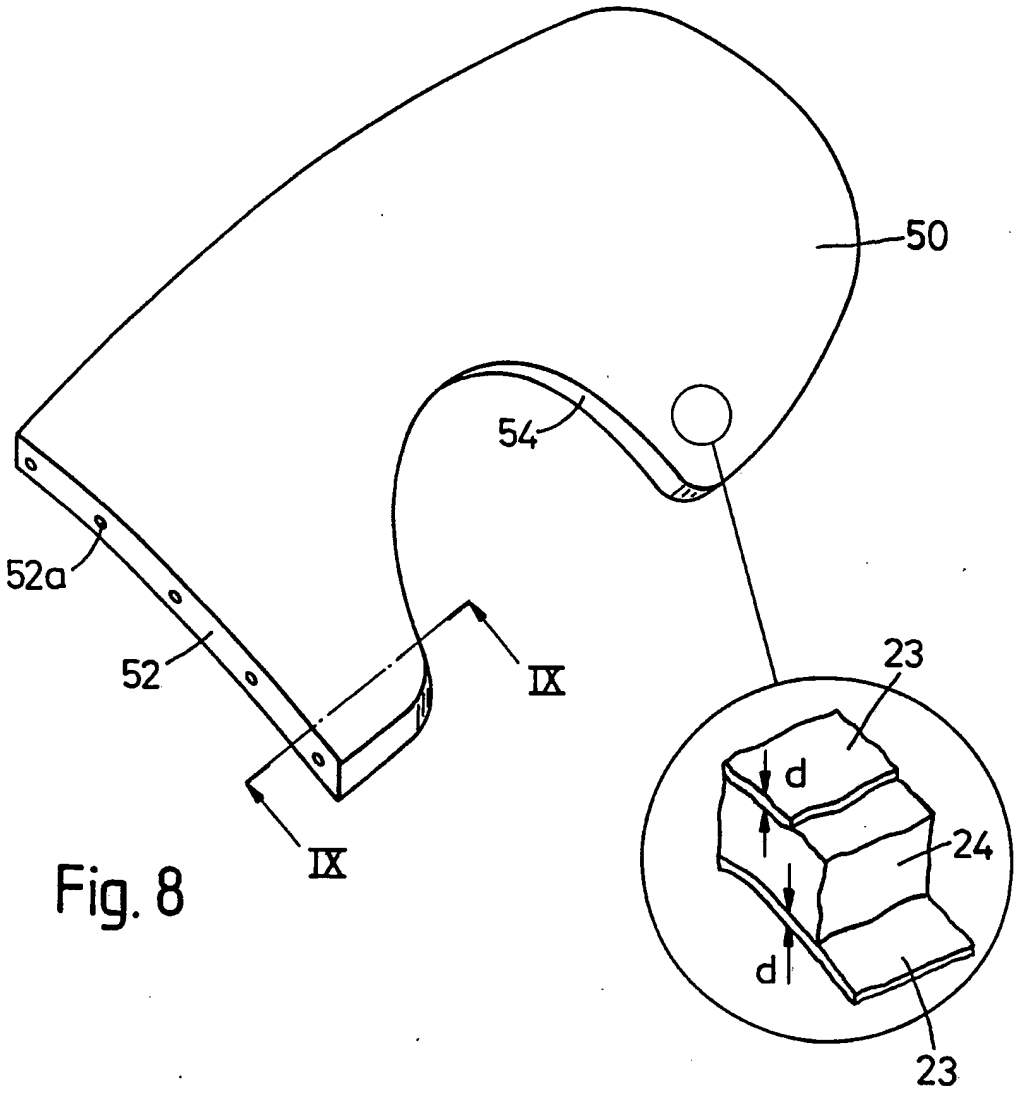

Fig. 8

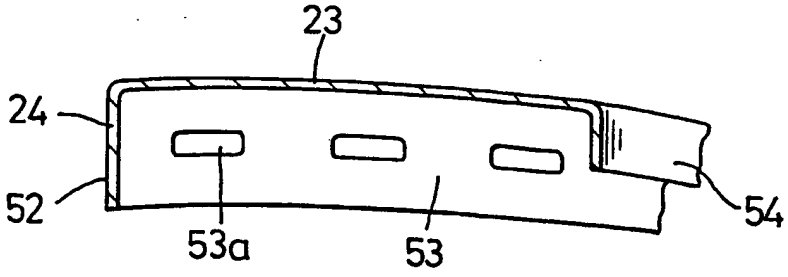

Fig. 9

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 93/00453

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 B29C45/16

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	B29C

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
Y	GB,A,2 080 187 (PONT-A-MOUSSON) 3 February 1982 cited in the application see the whole document	1-4,6,8, 11-14, 16,17, 21,22
Y	FR,A,2 079 295 (IMPERIAL CHEMICAL INDUSTRIES) 12 November 1971 see the whole document	1-4,6,8, 11-14, 16,17, 21,22
A	EP,A,0 309 933 (FIAT AUTO) 5 April 1989 see the whole document	1,12,22

° Special categories of cited documents :[10]

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
14 JUNE 1993	28 -06- 1993
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	BOLLEN J.A.G.

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

GB 9300453
SA 71436

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on
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